PATENT

METHOD FOR CLEANING TEXTILE ABSORBERS

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CROSS REFERENCE TO RELATED APPLICATIONS: Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT: Not applicable.

REFERENCE TO A SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX: Not Applicable.

BACKGROUND OF THE INVENTION:

[0001] The present invention relates to a method and apparatus for cleaning fabrics.

[0002] The desorption or removal of extraneous substances from fabrics is a prevalent industrial process. As used herein, the term "extraneous substance" refers to any substance that becomes attached to or is absorbed by a fabric during the use of the fabric. Extraneous substances can include dirt, industrial lubricants such as oils, grease, coolants, water, glycol, and solvents, as well as particulates. As a result, the current art contains a variety of different methods by which these substances are either removed from a fabric so that the fabric can be reused.

[0003] The steps that are used to separate extraneous substances from fabrics so that the fabrics can be cleaned or recycled for reuse must be chosen so that the desired results: maximum recycling and minimum waste generation are achieved.

Optimization of recycling inevitably results in a process that is specific to a particular waste stream; that is, the steps of that process will be dictated by the fabric and the composition of absorbed extraneous substance.

[0004] The optimization of the cleaning process, on the other hand, is dictated by those steps that will result in the cleanest materials. Further, the goal of maximum recycle of fabrics and cleanest fabrics is often associated with the generation of harmful wastes to the environment.

[0005] In response to the need for a cleaning process that is simple, effective, and allows the recycling of fabrics for reuse, the present inventor developed a process described in U.S. Patent Numbers 6,230,353 and 6,536,061. Although this process met existing needs, it did not address the growing concern regarding typical dry cleaning fluids, such as perchloroethylene. Because various local, state, and federal agencies consider these dry cleaning fluids to be hazardous wastes, the use of them in a cleaning step necessitates their treatment and/or disposal. Not only is hazardous waste disposal costly, but it imposes significant requirements for careful handling in order to protect the environment. Perchloroethylene is also considered to be a health hazard to those that may become over exposed to its fumes if not properly handled and ventilated.

[0006] Furthermore, common dry cleaning fluids oftentimes require the use of single to multiple industrial distillers to accommodate their high distillation points. These types of distillers consume significant energy resources and require careful monitoring.

[0007] Although cleaning methods thought to be environmentally friendly alternatives to dry cleaning exist, these methods bring with them additional complications and disadvantages. For example, the use of wet cleaning implicates the environmental regulation of water. Another cleaning method uses liquid carbon dioxide as an alternative to perchloroethylene. However, this method requires the use of specially designed machines capable of handing the high pressure required to sustain liquid carbon dioxide.

[0008] Therefore, there remains a need for a process for removing extraneous substances from fabrics that is simple, safe, effective, environmentally sound, and energy conserving.

SUMMARY OF THE INVENTION:

[0009] The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0010] According to its major aspects and briefly stated, the present invention is a method and system for removing extraneous substances from fabrics so that the fabrics can be recycled for reuse. In the case of the fabrics, recycle means that the fabrics are ready for reuse following application of the present process. Because some of the extraneous substances removed, such as oil, are also capable of being recovered and recycled, in the case of these substances, recycle may require further steps.

[0011] The present invention has industrial applicability, because it enables the cleaning of various materials used for industrial processes so that these materials can be reused. For example, such materials as shop cloths and oil-absorbers can be effectively cleaned for reuse without the need to employ environmentally harmful cleaning agents. Although this invention has industrial applicability, it is in no way limited to this applicability. For example, the present invention may also be applied to the cleaning of clothes.

[0012] The main component of the system is a cleaning component. Fabrics bearing extraneous substances are cleaned through the use of a particular cleaning fluid. The specific cleaning steps are not critical to the process as long as the cleaning fluid used is n-propyl bromide. Additionally, the system can include an excess extraneous substance removal component that precedes the cleaning component so that less energy is spent cleaning the fabrics in the cleaning component.

[0013] If the system includes the optional excess substance removal component, excess extraneous substances, such as oil and metal chips, can be removed from the fabrics by gravity draining by mechanical squeezing, by centrifuging, or by the combination of these. For example, these extraneous substances can be drained by placing oil-absorbing materials into drums and allowing the substances to drain from the fabrics to the bottoms of the drums. Alternatively, the extraneous substances can be drained by gravity into a sump. Additionally, extraneous substances can be removed by manually wringing or squeezing the fabrics. The removed extraneous substances can then be pumped to a settling tank where they can be removed or recovered by various recovery techniques known in the art.

[0014] In the cleaning component of the present system, the fabrics are cleaned by a cleaning technique, which employs the cleaning fluid n-propyl bromide. Although the cleaning technique is not critical, a preferred technique is dry cleaning. For example, the fabrics can be dry cleaned using an industrial dry cleaning machine. Additionally, the dry cleaning machine can be a closed loop machine that is connected to a distiller, a dry cleaning fluid tank for storing the dry cleaning fluid, and a waste container. Through the use of a closed loop dry cleaning machine, the cleaning fluid may be distilled and reused for multiple cycles. However, it is also contemplated by the present invention that various cleaning apparatuses and methods can be used other than dry cleaning. If a closed loop dry cleaning machine is used, the effluent from dry cleaning the fabrics is distilled to remove as much extraneous substance from the cleaning fluid as possible and to assure that the dry cleaning fluid, when reused to dry

clean the fabrics, is as clean as possible. Although the use of one distiller is sufficient for the process of the present invention, it is also contemplated that two distillers be used so that the cleaning fluid is distilled twice not only to ensure that the cleaning fluid is as clean as possible when it is reused, but to ensure there is always sufficient cleaning fluid available for reuse in new cleaning batches. The extraneous substance collected in the distiller is thereafter removed and handled appropriately depending on the type of extraneous substance.

[0015] A feature of the present invention is the use of a particular cleaning fluid that is an environmentally sound improvement over common cleaning products, such as chlorinated solvents. The use of n-propyl bromide is an advantageous alternative for chlorinated solvents, such as perchloroethylene. This compound is extremely effective at separating oils and greases from oil-absorbing materials, such as polypropylene. Furthermore, n-propyl bromide leaves these materials with a fresher scent and a softer feel than the chlorinated solvents. Whereas perchloroethylene may be most effective at removing the types of oils found on the human body, n-propyl bromide appears to be more effective at removing the types of oils found in industrial processes. More importantly, n-proply bromide is not considered by federal and state agencies to be a hazardous substance. Accordingly, users of this compound do not require all of the permits typically mandated by local, state, and federal agencies. This result greatly reduces compliance costs. Although n-propyl bromide is on the whole more costly than chlorinated solvents, these additional costs are more than recouped by the decrease in energy costs required to incorporate n-propyl bromide into the cleaning component of

the present process. For example, forty percent less energy is used when n-propyl bromide is the cleaning fluid as when perchloroethylene is used. Moreover, the properties of n-propyl bromide are such that a shorter drying time is required for fabrics. Accordingly, throughput of the fabrics is dramatically increased.

[0016] Another feature of the present invention is the optional component including the removal of excess extraneous substance. A considerable amount of extraneous substances can be removed from fabrics simply by allowing them to drain. Not only does excess extraneous substance drain readily from the fabrics, but also particles and metal chips can be removed in this way. By minimizing the amount of residual lubricants and particles in the fabrics in this optional component of the present process, more extraneous substance is recovered and the cleaning component is more effective in cleaning the fabrics for recycle.

[0017] Other features and advantages of the present invention will be apparent to those skilled in the art from a careful reading of the Detailed Description of the Invention presented below and accompanied by the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the drawings,

[0018] FIG. 1 is a schematic diagram of the first component of a cleaning system according to an embodiment of the present invention;

[0019] FIG. 2 is a schematic diagram of the second component of a cleaning system according to an embodiment of the present invention; and

[0020] FIG. 3 is a flow chart of a process according to an embodiment of the present method.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Referring now to FIGS. 1-3 there are illustrated schematic diagrams and a flow chart of a method and apparatus for separating extraneous substances from fabrics according to the present invention. It is contemplated by the present invention that any type of fabric, be it woven, non-woven, natural, or synthetic, can be cleaned using the following method. Furthermore, it is also contemplated that any type of extraneous substance that typically attaches to or becomes absorbed by fabrics can be removed or desorbed by the following method. Although there is no end of extraneous substances and fabrics for which the present invention is applicable, by way of example, the following description will focus on industrial-type fabrics and extraneous substances affecting these fabrics.

[0022] The desorption of extraneous substances, such as oil and other industrial lubricants, from absorbent materials is a prevalent industrial process. Absorbent fabrics used in industrial settings include synthetic and natural, woven and non-woven fabrics, which may come in the form of pads, sheets, shop cloths, and tubular "socks," and which are customarily used in machine shops and metal fabricating plants to absorb

spilled or leaking lubricants. Additionally, the industrial uniforms used in these plants become soiled with similar extraneous substances. For convenience, these fabrics will be referred to herein and the claims that follow as textile absorbers. As used herein, "textile absorbers" refer to fabrics and other manufactured products made from natural or manufactured fibers and filaments, as well as yarns, which have the ability to take up another material. Common textile absorbers include of polypropylene and polyester and cotton.

[0023] A goal of the present invention is recycling; in particular, the present system cleans textile absorbers for reuse. The more effective the present system is, the more extraneous substance it recovers, the cleaner the textile absorbers are, and the less hazardous waste it generates. As discussed, the main component of the present invention is the cleaning component. However, an optional component to the present process is a removal component in which excess extraneous substance is removed from the textile fabrics. This optional component is directed to the separation of and recovery of extraneous substances from the textile absorbers. In the cleaning component, the textile absorbers are cleaned using means and method for cleaning the textile absorbers so that these absorbers can be reused and so that the production of waste products during cleaning is minimized. Waste products are reduced in this component by using a particular kind of dry cleaning fluid.

[0024] Although the removal of excess extraneous substance is an optional component of the present invention, the cleaning process or component may be more

effective if excess extraneous substance is removed prior to cleaning. Accordingly, and referring now to FIG. 1, textile absorbers **10** are sometimes collected in barrels **12** for a period of time prior to beginning the present process. While standing in barrels **12**, extraneous substances, such as oil, lubricants, and solvents will drain down through a stack of textile absorbers **10**, pooling in the bottom of barrels **12**. Textile absorbers **10** at the top of the stack will be relatively free of excess extraneous substance; those at the bottom will contain excess extraneous substance, perhaps being soaked in it. The longer the barrels **12** stand undisturbed, the more extraneous substance will drain to the bottom.

[0025] Textile absorbers **10** that are located near the top of the barrels **12** can go directly into the cleaning component of the present process. Textile absorbers **10** located near the bottom of the barrels **12** can be placed on an elevated coarse grid **20** over a collection basin **22** to drain additional extraneous substance from them. The longer the textile absorbers **10** are allowed to drain, the less extraneous substance will have to be removed from the textile absorbers **10** in the cleaning component of the present invention. Alternatively, textile absorbers **10** located near the bottom of the barrels **12** can be manually wrung or squeezed mechanically so as to remove excess extraneous substance before the textile absorbers **10** enter the cleaning component of the present process.

[0026] Although the use of the elevated grid **20** and collection basin **22** is an optional feature of the present invention, if used, preferably a fine mesh grid **24** is

located below the elevated coarse grid **20**. Extraneous substance drains through the coarse and fine mesh grids **20**, **24**, to the lower portion of the basin **22**. Particles, dirt, metal chips, and cuttings collect on fine mesh grid **24** and can be removed in a variety of ways, such as vacuuming. If the textile absorbers **10** have been stored in barrels **12**, extraneous substance pooled in the bottom of the barrels **12** can be poured directly into collection basin **22**.

[0027] In order to further remove excess extraneous substances from the textile absorbers **10** before entering the cleaning component of the present invention, the textile absorbers **10** can be centrifuged at a high speed in a centrifuge **30** with a vertical axis **32** of rotation. Preferably, the centrifuge **30** operates at 900-1200 revolutions per minute (RPM) so that in approximately three minutes, the excess extraneous substances are removed so that the textile absorbers **10** have less than 2% and preferably less than 0.5% extraneous substances remaining.

[0028] From collection basin **22** and from centrifuge **30**, the extraneous substances, such as oil, can then be directly shipped to a processing facility, such as a refinery. Alternatively, the extraneous substances can first be transferred to an recovery system. For example, if the extraneous substance is made up mostly of oil, the oil can be pumped through filters **40**, **42**, using pumps **44**, **46**, respectively, to a settling tank **50**. Filters **40**, **42**, remove additional particulate although some will collect on the fine mesh grid **24** of collection basin **22** and more will settle to the bottom of the basin **22**.

[0029] In the settling tank **50**, the extraneous substances are allowed to stand so that fine particulate settles to the bottom as sludge while the fluid substances rise to the top. Water that has mixed with the extraneous substances tends to separate below these substances but above the heavier sludge. Settling tank **50** is equipped with a pipe **52**, located within the upper region of the tank **50** and in fluid communication with its interior. When the oil reaches a certain level, it enters pipe **52** and flows, by gravity, to a first barrel **54**. Periodically, the extraneous substances collected are pumped using pump **56** through a bag filter **58** to storage tank **60**. Preferably, filter **58** is sized to capture solids having a particle size greater than or equal to approximately 200 microns.

[0030] Extraneous substances from lower elevations of settling tank **50** drain to an evaporator **64**. Heat from a heat source **66** is applied to evaporator **64** to remove water from these extraneous substances. Then the extraneous substances are skimmed from evaporator **64** and drained to a second barrel **68**. Periodically, extraneous substances that are collected are pumped by pump **56** to holding tank **60** via bag filter **58**.

[0031] The extraneous substances recovered from the textile absorbers **10** and separated from both particulate by bag filter **58** and from water by evaporator **64** can thereafter be shipped to a refinery for further processing.

[0032] In the cleaning component of the present process, textile absorbers **10**, following the removal of excess oil by gravity draining, by gravity draining in combination with centrifuging, by wringing, or squeezing, are cleaned using n-propyl bromide as the cleaning fluid. A commercially available form of n-propyl bromide exists under the name TECHTRIDE®, which is sold for use in vapor degreasing. However, this form of n-propyl bromide contains various stabilizers, including ether and butylene oxide, which although advantageous in degreasing processes, are not necessary for the present process. Preferably, the cleaning fluid is 100% n-propyl bromide or consists essentially of n-propyl bromide. However, the cleaning fluid may also contain the stabilizers in the case that the particular cleaning method and apparatus dictates it.

[0033] Various cleaning methods and apparatuses can be employed in this cleaning component, and no particular cleaning technique is critical to the present invention. However, by way of example, a preferred cleaning technique is dry cleaning. In the case that dry cleaning is employed, textile absorbers **10** can be cleaned in an industrial dry cleaning machine **80**, shown in FIG. 2, that has been modified for the present purposes. The second component can be controlled by a computer controller **82**, operating various valves and pumps and other components as will be described, so that the operation can take place efficiently.

[0034] The cleaning component, which is illustrated in FIG. 2, also includes a distiller **90** to separate oils from the cleaning fluid. When dry cleaning the textile absorbers **10** using n-propyl bromide, the distiller **90** must be able to achieve a

temperature between approximately 70° F and 150°F to affect the phase separation. The distillation point of n-propyl bromide varies depending on the amount the particular extraneous substance with which it is combined. It is understood that the temperature at which separation occurs will vary as a function of both the dry cleaning fluid used and the type of lubricant removed, and therefore an artisan with ordinary skill would alter the temperature of the distiller accordingly.

[0035] As discussed, the use of n-propyl bromide is a particular feature of the present invention. This cleaning fluid is an environmentally sound and advantageous alternative to commonly used chlorinated solvents, such as perchloroethylene. N-propyl bromide is extremely effective at separating oils and greases from oil-absorbing materials, such as polypropylene. Furthermore, n-propyl bromide leaves these materials with a fresher scent and softer feel than the chlorinated solvents. Whereas perchloroethylene may be most effective at removing the types of oils found on the human body, n-propyl bromide appears to be more effective at removing the types of oils found in industrial processes. More importantly, n-proply bromide is not considered by federal and state agencies to be a hazardous substance. Accordingly, users of this compound do not need permits from federal and state agencies. This result greatly reduces compliance costs and permitting fees.

[0036] Although n-propyl bromide is more costly than a majority, if not all, of chlorinated solvents, and can cost as much as three times the cost of chlorinated solvents, these additional costs are more than recouped by the decrease in energy

costs required to incorporated n-propyl bromide into the cleaning component of the present process. On average, forty percent less energy is used when n-propyl bromide is the cleaning fluid as when perchloroethylene is used. Moreover, the properties of n-propyl bromide are such that a shortened drying time is required for the oil-absorbing materials. For example, the distillation point of n-propyl bromide when used in the dry cleaning process is between approximately 90° F, whereas the distillation point of perchloroethylene is approximately 265° F. Accordingly, the time needed to recycle the textile absorbers **10** is dramatically reduced and throughput of the textile absorbers **10** increased. Not only does the low distillation point of n-propyl bromide save on energy costs, but also it obviates the need for the use of industrial powered distillers. This lower distillation point also results in a safer working environment considering the process removes the need to operate equipment at extremely high temperatures or pressures.

[0037] Another advantageous difference between n-propyl bromide and perchloroethylene is that n-propyl bromide is much less dense than perchloroethylene. For example, 50 gallons of perchloroethylene equals approximately 700 lbs, whereas approximately 50 gallons of n-propyl bromide equals approximately 580 lbs. Accordingly, there is less stress on the dry cleaning machine when the same amount of n-propyl bromide is used as when perchloroethylene is used.

[0038] Still another advantageous property of n-propyl bromide is that it evaporates at a lower temperature than perchloroethylene. Consequently, textile

absorbers **10** require a shorter drying time, between approximately 15 minutes to 25 minutes, as opposed to 30 minutes to 60 minutes with perchloroethylene.

[0039] After textile absorbers **10** are put through a single cleaning cycle or washing in dry cleaning machine **80**, the effluent from the washing is pumped to distiller **90** where it is processed to clean the dry cleaning fluid by distilling the dry cleaning fluid from extraneous substances. The distilled n-propyl bromide from distiller **90** is then pumped to a holding tank **100** for use in dry cleaning machine **80**. Preferably, the distilled n-propyl bromide contains less than approximately 15% extraneous substances. Most preferably, the distilled n-propyl bromide contains less than approximately 5% extraneous substances. Waste from distiller **90** is pumped to waste tank **98** for proper disposal.

[0040] Holding tank **100** can be modified from that of conventional dry cleaning machines. The tank of conventional machines has partitions to define compartments for separating the n-propyl bromide into batches. In the present tank **100**, the partitions can be removed or modified so that the compartments communicate with each other and, if needed, the tank **100** is enlarged so that more n-propyl bromide is available for each load of pads **10**.

[0041] Other modifications include replacement of pumps **84** with larger capacity pumps and replacement of smaller electrical solenoid valves with pneumatic stainless steel ball valves **86**. In addition to these changes, the dry cleaner's internal lint filter is

also removed. An example of an industrial dry cleaner capable of use with the present invention is the Union U-2000 L Series in the 80 pound capacity size manufactured by Union Drycleaning Products of East Point, Ga.

[0042] Waste such as particles and metal fines from dry cleaning machine **80** are collected by trap **96** and vacuumed into waste tank **98**.

[0043] Textile absorbers **10** are then folded and packaged in clean plastic bas for return to the shipper. Extraneous substances from tank **60** are forwarded to a refinery for processing and reuse. Waste from various sources is sent to treatment facilities for processing and disposal.

[0044] It will be apparent to those skilled in the art that many changes and substitutions can be made to the preferred embodiment herein described with departing from the spirit and scope of the present invention as defined by the appended claims.